Therefore, the stray magnetic field, Hpin, from the pinned layer to the free layer is large. In addition, since more current flows above the free layer than below it, the current magnetic field Hcu applied to the free layer is large. Accordingly, for designing the bias point, it may be employable to control the bias point by canceling the large Hpin by the large current magnetic field Hcu.

The bias point values as calculated on the basis of the data obtained above are shown in Table 1. The sense current is 4 mA.

Table 1

Calculated Bias Point in Film of Comparative Case 1

MR height [micrometers]	Bias Point
0.3	70 %
0.5	61 %
0.7	53 %

As is known from Table 1, the bias point falls between 61 and 70 % when the MR height falls between 0.3 and 0.5 micrometers, and this oversteps the calculated best bias point range.

Fig. 11 is a conceptual view showing the condition of the bias point in Comparative Case 1. It is understood that reducing the MR height results in shifting of the bias point to the antiferromagnetic site (to the site larger than 50 %). The MR height inevitably fluctuates, owing to the mechanical

polishing. It is understood that the MR height distribution lowers the yield. Qualitatively, the reason is because the bias point is controlled in the extremely unstable method where the large pinned layer stray magnetic field Hpin is canceled by the large current magnetic field Hcu.

Except for the bias point, the film of this Comparative Case has still another essential problem. The problem is that the ultra-thin free layer to which the present invention is directed lowers the MR ratio. Through our experiments, we, the present inventors have found the fact that the MR ratio in the devices having a thinned free layer is extremely lowered after thermal treatment, and this is a serious problem with the devices. For example, in the film constitution of Comparative Case 1, the MR ratio in the as-deposited condition is around 11 %, but is 5.6 % after thermal treatment. That is, the latter is about a half of the former. In that condition, spin valve films practicable in high-density recording/reproducing systems could not be realized.

In the spin valve film of this Comparative Case, the layers are all thinned, and the sheet resistance of the film is around 30 Ω, and is large. In view of the electrostatic discharge (ESD), the film is not practicable. As well known, ESD increases with the increase in the resistance.

From the above, it is understood that the film of Comparative Case 1 is not practicable at all in high-density

recording heads.

Comparative Case 2: USP No. 5,422,591 (with spin filter but no Synthetic AF)

5 nanometer Ta/x nm Cu/1.5 nm NiFe/2.3 nm Cu/5 nm NiFe/11 nm FeMn/5 nanometer Ta (2)

In order to improve MR in the ultra-thin free layer therein, a spin valve film has been proposed, in which a high-conductivity layer is laminated on the free layer at the side opposite to the side of the nonmagnetic spacer layer. For example, referred to are USP Nos. 2,637,360, 5,422,591 and 5,688,605.

The film (2) is an example of the spin valve film based on USP No. 5,422,591. In this spin valve film, the Cu layer adjacent to the free layer at the side opposite to the side of the spacer Cu is thickened, whereby the mean free path for up-spin is prolonged to increase the MR ratio. However, if the Cu layer is too much thickened over the mean free path, it will be a simple shunt layer. Therefore, in this film, the MR ratio peak appears at a certain Cu layer thickness. Based on this phenomenon, one problem with the film of Comparative Case 1, that is, the reduction in the MR ratio owing to the ultra-thin free layer could be overcome in some degree.

However, the film constitution of the spin valve film (2) based on USP No. 5,422,591 has two problems. One is the problem with the bias point, and the other is the problem with